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ABSTRACT

To test two competing paradigms of the arousal-learning relationship--(1) increases in subject arousal will lead to increased learning in all but extreme cases of excitation, and (2) high subject arousal yields poor immediate memory but high ultimate memory--92 college students were presented with a tape recorded message in varying classroom environments of low predecrement (prestimulus) and high predecrement and postdecrement arousal. Students were then tested for either recall or recognition at 2-minute, 20-minute, and 1-week intervals. Consistent with laboratory findings, high predecrement arousal significantly facilitated both immediate and delayed recall and recognition. Inconsistent with laboratory findings, however, high postdecrement arousal did not significantly interact with the time of measurement to affect learning. Theories of recall were not supported by similar recall and recognition patterns in either situations. (Author/MM)

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The Effect of Communication Induced Arousal on Recall and Recognition

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CS 504 372

ABSTRACT

While arousal continues to interest communication researchers, few have directly tested competing paradigms of the arousal-learning relationship even where that relationship is thought to be the intervening variable for the phenomena being investigated. In order to provide such a test, 92 college undergraduates listened to a tape recorded message in varying environments of low pre-decrement and high pre- and post-decrement arousal and were tested for either recall or recognition at two minute, 20 minute, and one week intervals. Consistent with laboratory findings, high pre-decrement arousal significantly facilitated immediate and delayed recall and recognition. Inconsistent with laboratory findings, high post-decrement arousal did not significantly interact with the time of measurement to affect learning. Recall and recognition were affected similarly by pre- and post-decrement arousal which appears incongruent with theories of recall. Intentional instuctions to learn facilitated both recall and recognition which is inconsistent with previous research.

The effect of Communication Induced Arousal on Recall and Recognition

Communication induced arousal continues to receive attention as a significant intervening variable (Cappella & Greene, 1982). Recently particular concern has focused on the arousal-learning relationship as it relates to communicative behaviors (Dempsey & Reinsch, 1983; Steinfatt & Roberts, 1983). Unfortunately, these investigations tested only one of the potential paradigms suggested to characterize the relationship between arousal and information retention. This is odd given the conceptual diversification and confusion which pervade the arousal literature. Motivation, emotion, attention, and vigilance (in addition to others) have been used as synonyms for the arousal construct (Hall, 1971). Additionally, while there is no doubt that arousal has a significant influence on learning, there is by no means any concensus on the specific effects; either in terms of results or by what means they are achieved. Finally, there have been comparatively few attempts to duplicate even clear laboratory findings in natural communication settings.

In an attempt to determine if the generality of communication studies is being undermined by their failure to concern themselves with the variety of potential arousal-learning paradigms, this study will make a direct comparison of two such competing constructs within a communication environment typically utilized by researchers. Specifically, the effect of arousal on recall and recognition tasks will be tested within a classroom situation.

Laboratory studies of verbal learning have generated two basic views of the arousal-learning relationship. One position holds that

increases in subject arousal will lead to increases in learning in all except extreme cases of excitation where cognitive impairment results; i.e., an inverted-U relationship (Barry, 1962; Matzman, Kantor, & Langdon, 1966; McKusick, 1965; Stennett, 1957; Yarmey,1966). A second position argues that the active phases of memory perservation temporarily inhibits recall and thus high arousal results in greater ultimate memory but poor immediate memory (Kleinsmith & Kaplan, 1963, 1964; Kleinsmith, Kaplan, & Tarte, 1963; Walter & Tarte, 1963; Howarth & Eysenck, 1968). These studies suggest that the opposite is true for low arousal learning: greater immediate recall with poor ultimate recall.

The few empirical studies conducted in classroom situations have generally found a positive correlation (increases in attention correspond to increases in learning) between arousal and observed classroom behaviors (Cobb, 1972; Hudgins, 1967; LaHaderne, 1968; Samuels & Turner, 1974). These results appear supportive of the Berry et al. position of arousal-learning relations.

For our purposes, the major shortcoming of all these studies is their failure to test competing paradigms within the same design and environment. Additionally, these studies generally use only one type of learning task (particularly communication studies). As will be developed below, this may be a critical element in producing results which allow accurate discrimination between the expected effects of arousal manipulations.

There is a real danger of furthering coneptual confusion by equating physiologically based lab results with an experimental a priori groupings of classroom behaviors. However, since it is with such groups that experimenters must often work

(i.e., they cannot monitor the G.S.R. of individual students during a lecture), it seems reasonable that studies investigating the practical utility of laboratory findings should also deal with such constructs.

Before presenting the design of the present study it is necessary to clarify the Kleinsmith position. This theory views the time at which arousal occurs (relative to the presentation of a stimulus or message) as the key to predicting the effect arousal will have on learning. Arousal which occurs prior to the presentation of a stimulus (pre-decrement) is seen as a perceptual process which increases the sensitivity of a subject to stimulus reception and facilitates consolidation of memory traces; whereas the occurance of arousal immediately after the presentation of a stimulus is associated only with the consolidation process (Levonian, 1966). The occurence of pre-decrement arousal is thought to lead to improved short and long-term memory (as predicted by the Berry et al. position). The effect of post-decrement arousal on memory is a function of the strength of the arousal and an interaction with the passage of time. High post-decrement arousal produces poor immediate memory and greater ultimate memory, while low post-decrement arousal produces high immediate memory and poorer ultimate memory. The major assumtions of this position are decribed by Walker and Tarte (1963):

> The occurence of any psychological event, such as an effort to learn an item of a paired-associate list, sets up an active, perseverative trace process which persists for a considerable period of time. The perseverati ve

process has two important dynamic characteristics: (a) permanent memory is laid down during this active phase in a gradual fashion; (b) during the active period there is a degree of temporary inhibition of recall, i.e., action decrement (this negative bias against repetition serves to protect the consolidating trace against disruption). High arousal during the associative process will result in a more intensely active trace process. The more intense activity will result in greater ultimate memory but greater temporary inhibition against recall. (p. 113)

It is critical to note that the Kleinsmith studies all used cued recall learning tasks (e.g., paired-associate learning). Kaplan and Kaplan (1968) point out that the theory is seen as applying only to tasks which "involve the formation of new bonds or representations" in memory (p. 291). While Kaplan and Kaplan (1968) specifically exclude free recall from the bonds of the theory, it is not clear how recognition tasks (such as multiple-choice tests) would be affected by the arousal-time interactions they describe; although the recognition of content from a previously unknown message would require that a subject deal with 'new representations' in memory. Not only is this issue of theoretical interest, but also of practical consequence as multiple-choice questions are certainly among the most prevalent testing devices.

Theoretical models of recall (Kintsch, 1970; Anderson & Bower, 1972) have implications for extending the Kleinsmith position to recognition tasks. Both of the above models make a distinction between recall, which involves overt retrieval

of material from memory, and recognition which does not involve retrieval. If this distinction is accurate it would appear that recognition should not be affected by post-decrement arousal's inhibition of retrieval, or at least recall and recognition should not be affected in a similar manner. These models can allow pre-decrement arousal to influence recognition by being a determinant of the "familiarity value" of a word (Kintsch, 1970), or a type of "list marker" of an item's location in memory (Anderson & Bower, 1972); these being the cues by which people make recognition decisions. It would also seem that in the case of pre-decrement arousal effects on recall, the inhibiting consolidation process would be completed before the overt retrieval step in either model. Thus these models appear capable of incorporating the current laboratory data and allow a prediction of the effect which post-decrement arousal will have on recognition tasks.

Based on the discussion above it is predicted that: (1) a condition of high arousal prior to the presentation of a message will produce significantly greater recall and recognition of that message in immediate and delayed trials than a condition of low arousal prior to the presentation of a message, (2) a condition of high arousal which follows the presentation of a message will have no significant effect on the recognition of that message in either immediate or delayed trials, and (3) a condition of high arousal which follows the presentation of a message will produce delayed recall of that message which is significantly greater than the amount of recall of that message in immediate trials.

Method

Subjects

The subjects were 92 undergraduates, 43 male and 49 female, in six sections of the basic speech communication course at the during the Spring semester of . It was assumed that the sections selected for this experiment were typical of all students in the basic course. One section was assigned to each of the six experimental conditions (described below) as intact groups.

Procedures

The study consisted of two separate two-factor mixed design procedures, with repeated measures on one factor in each case; one procedure each for recall and recognition. The independent variables in each design were the level of arousal (low pre-decrement, or LPreD; high pre-decrement, or HPreD; and high post-decrement, or HPostD), and the time of measurement (immediate, 20 minute delay, one week delay). The dependent variable was the number of correct answers to either a 20 item multiple-choice question test (recognition) or a 20 item recall test.

The subjects were not told that they were involved in an experiment. The HPreD condition was operationalized by having the normal classroom instructor start the experimental class period by informing the subjects that they were to listen to a tape recording of a speech and would be given a test over the content of the message immediately after the conclusion of the speech. The subjects were told that the test would be graded and would be counted in their course grade. The intent of providing

subjects with knowledge that they are to be tested is to increase the arousal level of the subjects prior to the message presentation (Dempsey, 1974; Knower, Phillips, & Keoppel, 1945; Moore, 1919; Petrie, 1963; Prince, 1949).

For all conditions the message to be learned dealt with the effects of T.V. violence on children and was designed by Andersen (1972) to be informative rather than persuasive. Immediately after the tape recording was completed subjects were given a questionnaire which contained a set of semantic differential scales for the measurement of source credibility for peers (McCroskey, 1972) and either a recognition or recall test. The recognition test was a 20-item multiple choice test developed by Andersen (1972) and the recall test was a 20-item questionnaire developed by the experimenter to cover the same material as the recognition test items as closely as possiblle. However, as one instructor told her class not to answer one item on the recall test since she could not explain its intent, that item was excluded from analysis in all conditions. Subjects were told to place their name on the test. All conditions allowed for ten minutes to complete the test (either recall or recognition) in all trials except the immediate conditions where an additional two minutes were allowed for the completion of the credibility scales. After completion of the immediate trials the classes resumed their normal activities without discussion of the experiment. At the end of the same class session (20 minutes later) the subjects were again asked to complete one of the test forms as per their original instructions. One week later the subjects were given a final

learning trial. In no conditions were subjects aware there were to be delayed test trials.

The LPreD condition was operationalized by following the above procedures except subjects were not informed they were to be tested on the contents of the speech they were to hear. Following a procedure developed by Worchel and Arnold (1974) to maintain low arousal during experimental sessions, subjects were told to listen to the speech and determine if they formed impressions of the speaker's personality by just listening to him talk. The intent was to prevent direction of the subject's attention on the content of the message to a greater degree than he would when listening to a normal conversation. The subjects were told that this activity was being performed in connection with the units on interpersonal communication which the sections were currently engaged in. It was to add realism to this rationale that subjects were asked to complete the credibility scales (additionally the scales were completed in all sessions to standardize conditions). For comparisor purposes this condition may also be considered a low post-decrement condition if the low arousal environment persisted for the duration of the message.

The HPostD condition was operationalized by following the same procedures used in the LPreD conditions, except that an additional sentence was added to the message to create the impression that more material would follow. However, this sentence was interrupted by an 'over-dub' of music at which time the instructor acted surprised and apologized to the students for their not being able to hear the completed message. This task interruption was designed to produce a "Zeigarnick

effect (Van Bergen, 1968) which leads to a 'general, non-specific state of arousal' (Mandler, 1964; Worchel & Arnold, 1974) characteristic of post-decrement arousal of the Kleinsmith type.

Results

Data was collected from 92 subjects in the immediate and 20 minute delay trial conditions; however absentees from class meetings in the one week trial conditions reduced the number of subjects included in the analyses to 76. The data was analyzed by a two-way analysis of variance (Bruning & Kintz, 1968) and with Tukey H.S.D. multiple comparison tests where appropriate (Kirk, 1968). The criterion level for significance was set at the .05 level. As the source credibility measures were included only as a blind to help achieve low arousal conditions, the data generated by the scales was not analyzed for this study. No statistical comparison between recall and recognition was made due to the difficulty in compensating for guessing (Dale & Baddeley, 1962; Müller, 1913; Kintsch, 1970) within this design and the unequal number of answers which resulted from the experimenter error described above.

Recognition

The results of the analysis of variance for recognition scores are reported in Table 1 with the cell means and differences among them reported in Table 2 and graphed in Figure 1. The analysis of variance indicates a significant main effect for the level of arousal ($F = 8.77$, $p. < .001$) and the Tukey tests indicate that the HPreD condition produced

Table 1

Analysis of Variance: Recognition Scores

Source	SS	df	ms	F
Total	949.42	110	-	-
Between Subjects	728.75	36	-	-
Conditions	247.81	2	123.97	8.77*
$Error_b$	480.81	34	14.14	-
Within Subjects	220.67	74	-	-
Trials	16.77	2	8.39	3.19**
Trials X Conditions	24.73	4	6.18	2.33
$Error_w$	179.31	68	2.63	-

Note. Potential score range of 0 (low) to 20 (high)

* $p. < .001$

** $p. < .05$

Table 2

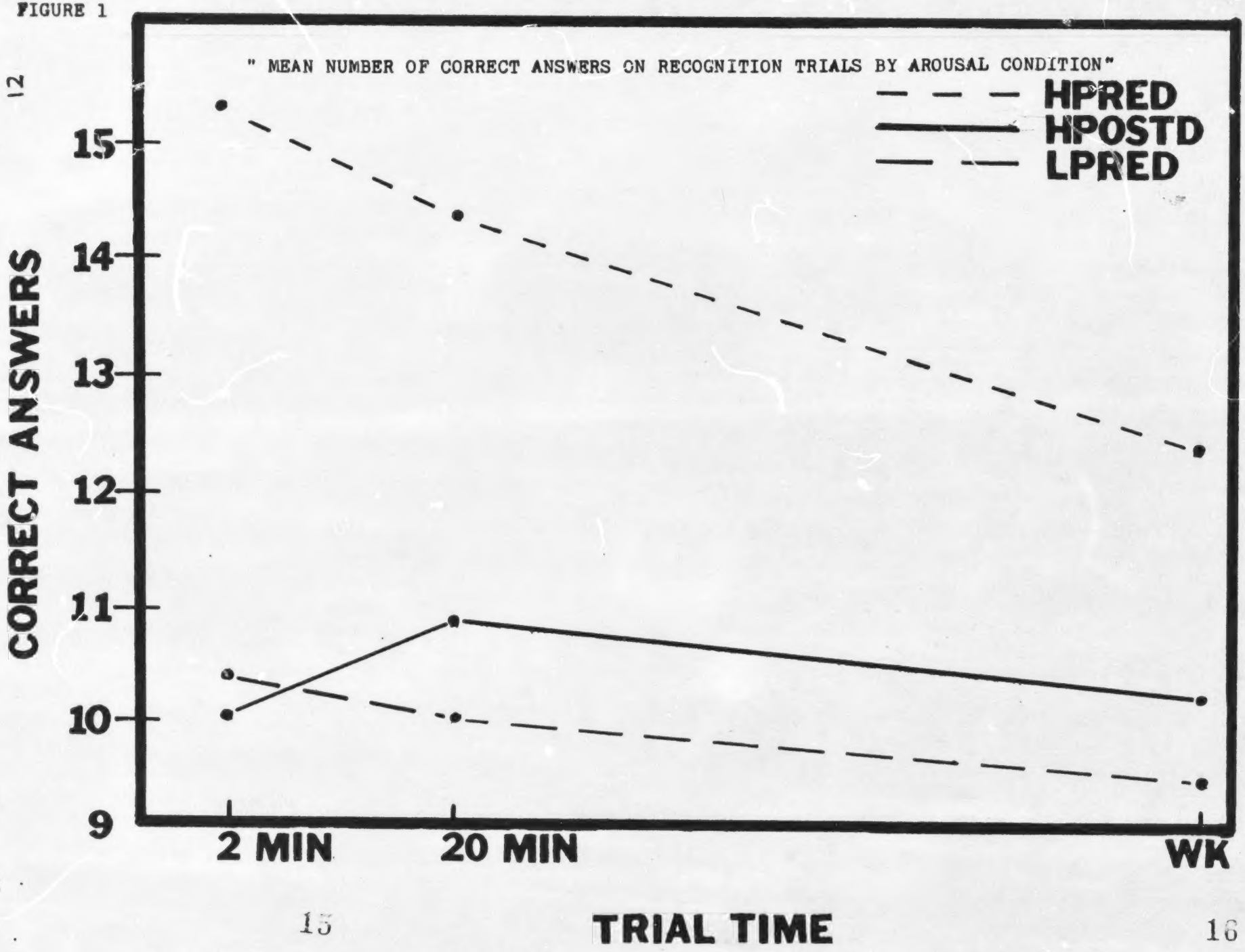
Inspection of Recognition Cell Means

Cell #	Condition		$\bar{X}$
	arousal	trial	
1	low-pre-decrement	immediate	10.43
2	low-pre-decrement	20-minute delay	10.07
3	low-pre-decrement	one-week delay	9.50
4	high-post-decrement	immediate	10.06
5	high-post-decrement	20-minute delay	10.88
6	high-post-decrement	one-week delay	10.25
7	high-pre-decrement	immediate	15.29
8	high-pre-decrement	20-minute delay	14.29
9	high-pre-decrement	one-week delay	12.43

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	$\bar{X}_5$	$\bar{X}_6$	$\bar{X}_7$	$\bar{X}_8$	$\bar{X}_9$
$\bar{X}_1$	-	.36	.93	.37	-.45	.18	-4.86	-3.86	-2.00
$\bar{X}_2$	-	-	.57	.01	-.84	-.18	-5.22	-4.22	-2.56
$\bar{X}_3$	-	-	-	-1.56	-1.38	-.75	-5.79	-4.79	-2.93
$\bar{X}_4$	-	-	-	-	-.82	-.19	-5.19	-4.19	-2.37
$\bar{X}_5$	-	-	-	-	-	-.63	-4.41	-3.41	-1.55
$\bar{X}_6$	-	-	-	-	-	-	-5.40	-4.40	-2.18
$\bar{X}_7$	-	-	-	-	-	-	-	1.00	2.86
$\bar{X}_8$	-	-	-	-	-	-	-	-	1.86
$\bar{X}_9$	-	-	-	-	-	-	-	-	-

Note. Score range of 0 (low) and 20 (high)

FIGURE 1


" MEAN NUMBER OF CORRECT ANSWERS ON RECOGNITION TRIALS BY AROUSAL CONDITION"
HPRED
HPOSTD
LPRED
CORRECT ANSWERS
15
14
13
12
11
10
9
2 MIN
20 MIN
WK
TRIAL TIME

significantly greater recognition then either the LPreD condition ($p. < .01$) or the HPostD condition ($p. < .01$). This data supports hypothesis one.

While the analysis of variance indicates a significant main effect for time (trials) ($F = 3.19$), the Tukey tests fail to reveal a significant comparison. The analysis of variance failed to reveal a significant interaction between the arousal elevel and the time at which recognition was tested ($F. = 2.33$). The failure to find a signficant difference between the immediate trial and either delayed trail for the HPostD conditions supports hypothesis two.

Recall

The results of the analysis of variance for the recall scores are reported in Table 3, with the cell means and the differences among them reported in table 4 and graphed in figure 2.

Table 3

Analysis of Variance: Recall Scores

Source	SS	df	ms	F
Total	1312.32	107	-	-
Between Subjects	980.32	35	-	-
Conditions	442.59	2	221.30	13.09*
$Error_b$	643.41	33	16.90	-
Within Subjects	332.00	72	-	-
Trials	36.35	2	11.18	4.27**
Trials X Conditions	14.77	4	3.69	< 1
$Error_w$	281.00	66	4.26	-

Note. Potential score range of 0 (low) to 19 (high)

* $p. < .001$

** $p. < .025$

Table 4

Inspection of Recall Cell Means

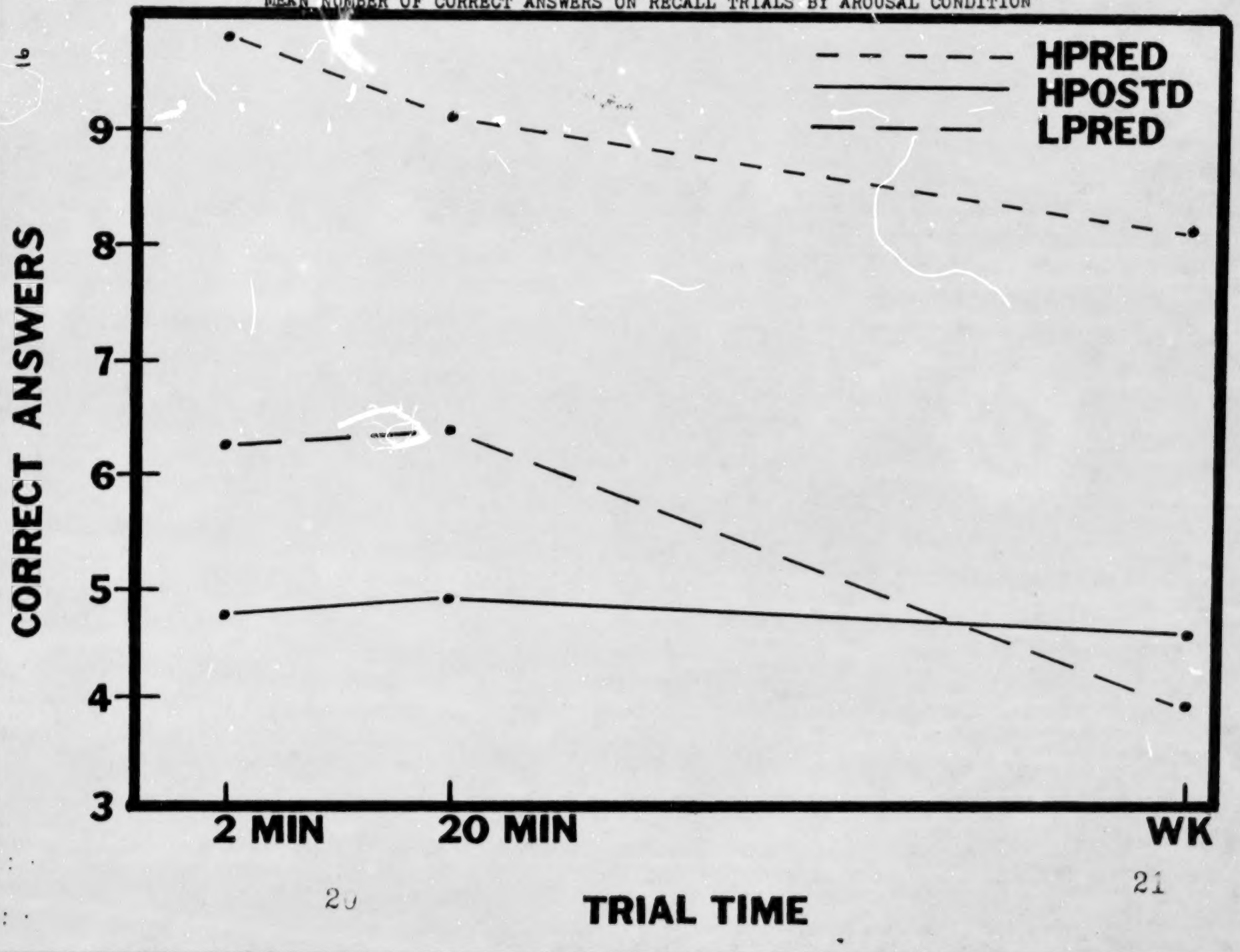
Cell #	Condition		$\bar{X}$
	arousal	trial	
1	low-pre-decrement	immediate	6.29
2	low-pre-decrement	20-minute delay	6.43
3	low-pre-decrement	one-week delay	4.00
4	high-post-decrement	immediate	4.85
5	high-post-decrement	20-minute delay	4.92
6	high-post-decrement	one-week delay	4.53
7	high-pre-decrement	immediate	9.81
8	high-pre-decrement	20-minute delay	9.31
9	high-pre-decrement	one-week delay	8.31

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	$\bar{X}_5$	$\bar{X}_6$	$\bar{X}_7$	$\bar{X}_8$	$\bar{X}_9$
$\bar{X}_1$	-	-.14	2.29	1.44	1.37	1.76	-3.52	-3.02	-2.02
$\bar{X}_2$	-	-	2.43	1.58	1.90	2.43	-3.38	-2.88	-1.88
$\bar{X}_3$	-	-	-	-.85	-.92	-.53	-5.81	-5.31	-4.31
$\bar{X}_4$	-	-	-	-	-.07	.32	-4.96	-4.46	-3.46
$\bar{X}_5$	-	-	-	-	-	.39	-4.89	-4.39	-3.39
$\bar{X}_6$	-	-	-	-	-	-	-5.28	-4.78	-3.78
$\bar{X}_7$	-	-	-	-	-	-	-	.50	1.50
$\bar{X}_8$	-	-	-	-	-	-	-	-	1.00
$\bar{X}_9$	-	-	-	-	-	-	-	-	-

Note. Score range of 0 (low) to 19 (high).

FIGURE 2

" MEAN NUMBER OF CORRECT ANSWERS ON RECALL TRIALS BY AROUSAL CONDITION"



The analysis of variance reveals a significant main effect for the level of arousal ($F = 13.09$, $p. < .001$) and the Tukey tests indicate that the HPreD condition produced significantly greater recall than either of the LPreD or HPostD conditions ($p. < .01$). This data supports hypothesis one.

As in recognition, while the analysis of varience indicates a significant main effect for time (trials) ($F = 4.25$, $p. < .025$), the Tukey tests fail to reveal a significant comparison.

The analysis of variance indicates no significant interaction was present. Comparison of means indicates that the HPreD means were significantly different ($p. < .01$) from both the LPreD and the HPostD means on every trial, except at the 20 minute delay trial where the difference between the HPreD and the LPreD means is significant at the .05 level. There were no significant differences between any of the LPreD and the HPostD means. The failure to find a significant difference between the immediate trial and either delayed trial for the HPostD condition also fails to support hypothesis three.

Discussion

Analysis of both recall and recognition scores yielded support for hypothesis one; high pre-decrement arousal

significantly facilitates both immediate and delayed memory. This finding is consistent with previous studies conducted both in laboratory and classroom situations. The implication of this finding for educators is clear; instructions to students concerning classroom behaviors and the nature of class activities (e.g., variety, levels of student participation, variation in modes of presentation of material) can directly influence student arousal levels and thus learning performances.

While the analyses of variances indicated significant main effects for the time at which memory was measured (simply indicating that students forget material as time passes), when the three arousal conditions were collapsed the Tukey tests failed to detect significant differences. Examinations of Figures 1 and 2 suggest that resistance of the high post-decrement groups to forgetting (a decrease of only .32 in one week for recall, and a gain of .19 in one week for recognition) probably was enough to cancel the very gentle forgetting curves of the other conditions over this short time period. This suggestion is offered mild support by a post hoc Duncan's range test (Bruning & Kintz, 1968) indicating a significant difference ($p. < .025$) between the rates of forgetting between the HPreD and the HPostD groups in the recognition tasks; however, no other such significant differences were found between any other treatments in either recognition or recall.

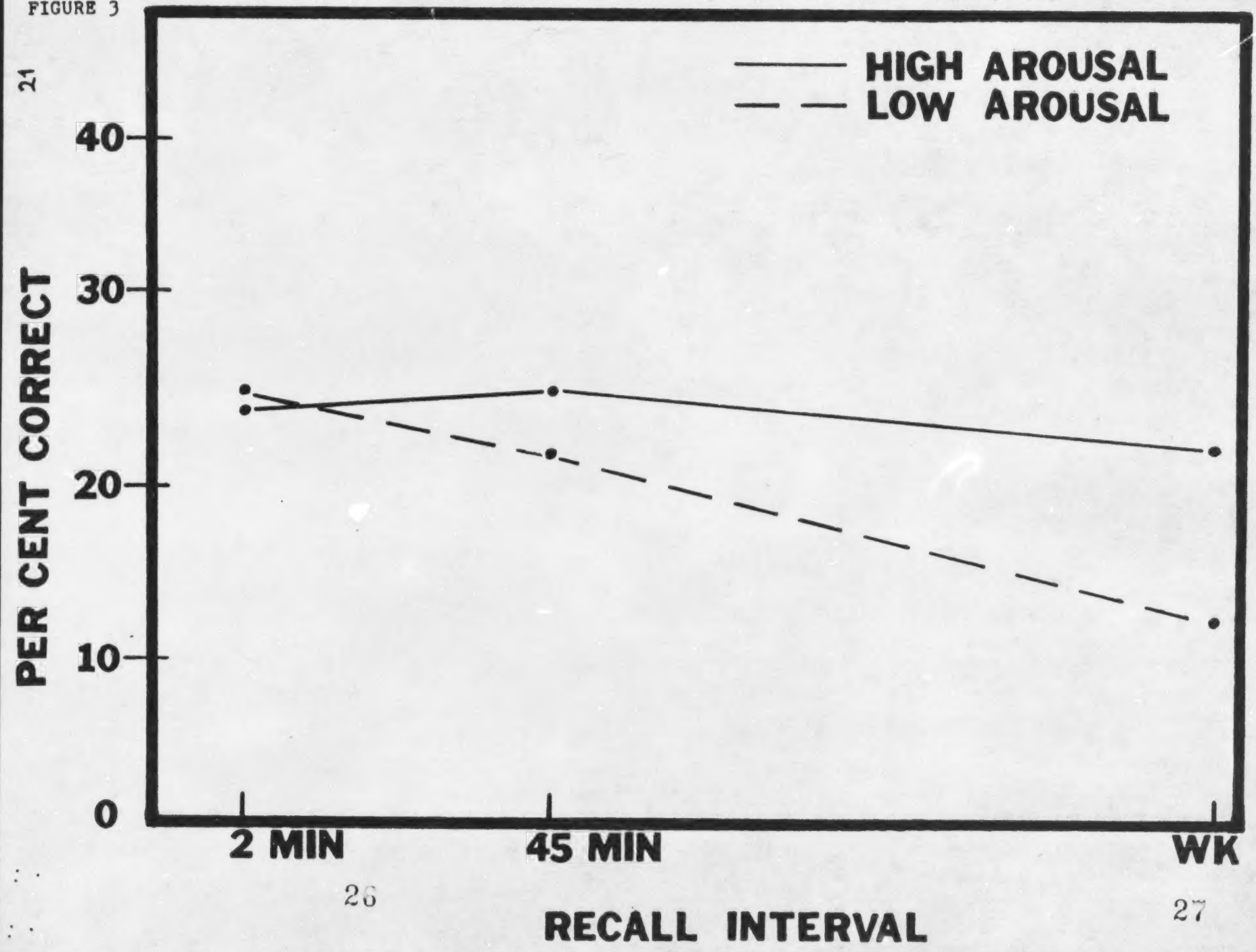
While the failure to find greater delayed recognition for the HPostD condition supported hypothesis two, a similar failure

was experienced in the recall tasks and offered no support for hypothesis three. There are several lines of analysis relevant to this finding. The first concerns the methodology of the present design as it is apparent that several potentially confounding influences may have been incorporated in the rationale and design. First, the conceptual confusion in the literature regarding the the arousal construct suggests that what Mandler (1964) calls "general, nonspecific arousal" in predicting the effect of task interruption simply may not be the same type of nonspecific arousal described in the Kleinsmith paradigm. Even assuming conceptual clarity there are two possible errors in operationalizing the "Zeigarnick effect". One is that the material and/or delivery of the speech itself created a masking arousal condition prior to the task interruption; this is impossible to determine because it would depend upon the reaction of each individual subject and there is no measure of such reactions within the present design. Second, even assuming an otherwise low pre-decrement arousal environment was maintained prior to the task interruption it is difficult to tell if the effect of the nonspecific arousal would influence the retention of items that preceded it by as much as four minutes. Kaplan and Kaplan (1968) indicate learning is predicted by arousal occurring after the presentation of the stimulus message but that the critical lag time varies with the material and subjects. Levonian (1966) found a lag of about 30 seconds to be the best predictor in recalling the content of a ten minute movie. However, Glickman's (1961) summary of the literature

indicates that the consolidation processes may be affected up to an hour or more after their initiation, although the shorter the lag the stronger the effect. In studies which used drugs to manipulate arousal, Pare (1961) has produced additional evidence that post-decrement arousal can affect retention in extended learning tasks. Thus the evidence relating to how much of the message should have been affected by the "Zeigarnick effect" is inconclusive and makes any interpretation of the present results tentative.

It is also possible that the wrong effect was predicted for the post-decrement manipulation (hypotheses 2 and 3). If the original Kleinsmith et al. methodology is examined it becomes apparent that a statistically significant difference between immediate and delayed recall was found only when subjects experiencing the extreme upper or lower levels of post-decrement arousal were grouped and mid-range levels excluded from analysis. When subjects experiencing these milder arousal conditions were included in the high and low groupings, learning curves very similar to those in the present study were found (Walker & Tarte, 1963; see Figure 3 for a graph of a sample curve). It appears reasonable that the a priori groupings used in the present design would approximate the mixed groupings in the Walker and Tarte (1963) study rather than the more extreme groupings typical of the Kleinsmith research. Thus it would appear possible that the results of the present study represent a valid "Zeigarnick effect" and a resulting Kleinsmith interaction; and that the effect of such an interaction is to produce learning which is stubbornly resistent to decay. That resistance to forgetting was

FIGURE 3


HIGH AROUSAL
LOW AROUSAL
PER CENT CORRECT
40
30
20
10
0
2 MIN
45 MIN
WK
RECALL INTERVAL

evident in both recall and recognition tasks; in the recognition trials the difference between the HPreD and HPostD groups moved from a .01 statistically significant difference in the immediate trials to a performance level that was not significantly different at one week, while the results in the recall tasks were similar but not statistically significant. Not only is this interesting in light of arousal theory, but for its implications for the recall models described earlier. While the statistical evidence on the point in the present study is meager, the apparent similarity of the effect on both recognition and recall by the HPostD conditions should not have been observed if recall involves a retrieval phase which recognition does not. Stronger evidence was reported to show that intentional instructions to learn (the high pre-decrement arousal manipulation) significantly facilitated both recall and recognition, a fact in direct contradiction of evidence of a reversal effect on recognition and facilitation of recall by intentional instructions (Dornbush & Winnich, 1964; Eagle & Leiter, 1964; Postman, Adams, & Phillips, 1955). This is of potential importance since it is the findings of studies reporting variables that affect recall and recognition in different ways which are cited as evidence against the viability of 'strength' models (Bahrick, 1965; McDougall, 1904; Postman, 1963) of recall and support for a two-stage process in recall (Anderson & Bower, 1972). However, strength models would not appear to offer a rationale for the Kleinsmith time by arousal interaction effect on recall, since in this case

recall performance increases over time when the strength of an item would normally be expected to fade. Additionally, both the Kintsch (1970) and Anderson and Bower (1972) recall models may be able to explain the similar effects on recall and recognition by the HPostD condition if trace reverbration in the consolidation processes set up by a HPostD condition affected of blocked access to 'familiarity values' or 'list markers' as well as to access to overt retrieval. Thus the results in this study which suggest similar effects on recall and recognition merely suggest a variable of interest for recall theorists rather than offer indictments of specific recall models, and in turn such models cannot be taken as proof that high post-decrement arousal can be expected to be irrelevant or insignificant to recognition.

The discussion section has already indicated a number of theoretical and methodological aspects that future replications and new investigations should take care in correcting. Truely rigorous investigations may have to wait for the development of a measure of arousal that can be easily and practically incorporated in normal classroom environments without creating confounding arousal manipulations of its own (as the use of electronic equipment may). However, the extreme difficulty that any study will face in attempting to operationalize and isolate post-decrement arousal effects in a classroom may mean that they are too complex to be controlled or compensated for by educators. This should not obscure the fact that arousal has other powerful influences on learning (e.g., pre-decrement manipulations) that educators can make immediate practical applications.

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